

# Measuring process performance in hospitals

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## Abstract

To increase efficiency and simultaneously the quality of their operations, hospitals invest in process management and process optimization from an organizational and patient perspective. Consequently, the use of process-oriented performance measurement systems gains importance. This study contributes to the development of a dashboard for the process of hip surgery using a case study design. We integrate strategic goals of hospital management and different stakeholders with the more analytical analysis of Business Process Management and Hospital Information Systems' data. Process-oriented KPI's were integrated into the dashboard using a three-step approach. Dashboards enable healthcare organizations to put process-oriented performance measurement into practice.

**Keywords:** Process management, Performance measurement, Healthcare

## Purpose

From a historical point of view, hospitals are organized along functional departments. Since the evolution of healthcare services, hospital structure has been characterized by increasing specialization (within the functions) and centralization (to capture economies of scales). Patients are staying in small, specialized patient units supported by multiple ancillary and support departments (Gemmel et al. 2008). During the last decade, hospitals have tried to move from functional towards process-oriented organizational forms (Vera and Kuntz 2007). Process orientation of organizations leads to speed improvements, increase of customer satisfaction, improvement of quality, reduction of cost, and improvement of financial performance (Kohlbacher 2010). To simultaneously increase the efficiency and quality of their operations, hospitals invest in process management and process optimization (Vissers and Beech 2005). However, the current culture in hospitals is still not sufficiently evolved towards a more integrated and holistic vision of the entire organization, mainly due to the absence of clear process thinking and the lack of knowledge about identifying and monitoring these processes with operational and strategic indicators (Gemmel et al. 2008).

Process-orientation of a hospital assumes an integrated view on the flows of materials, information and patients (Villa et al. 2009). Two main types of processes can be identified according to Porter et al. (2013): First, the actual “treatment” processes aiming to care or cure, whereby “treatment” includes all medical and clinical activities related to diagnosis, therapy, surgery or other care. Second, the “supporting” processes that target to support the “treatment” of a patient. Supporting processes include all non-treatment processes; e.g. logistics, human resources, purchasing. Figure 1 provides an overview.

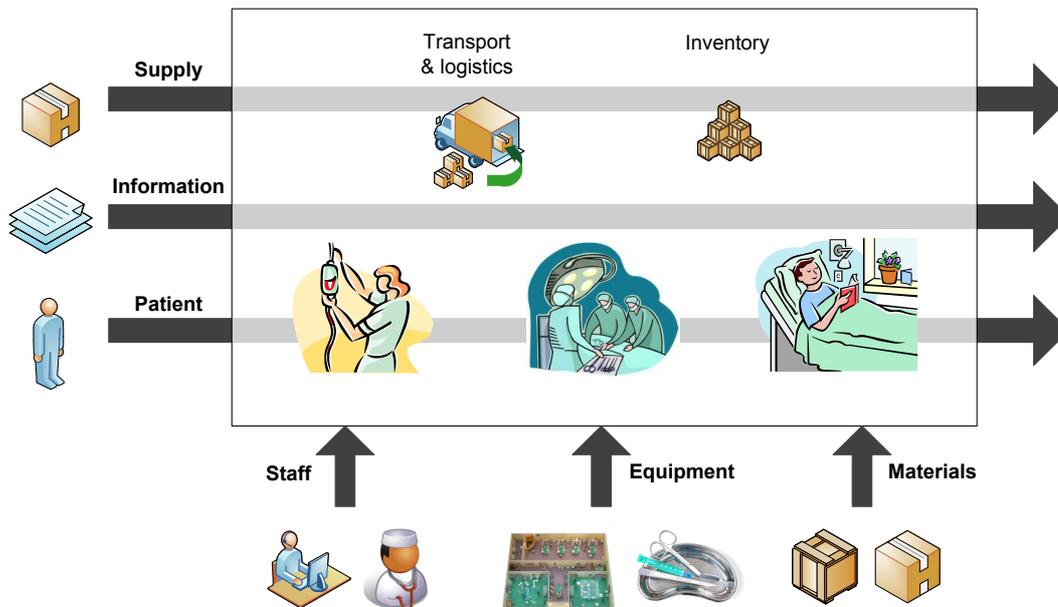


Figure 1-Types of hospital flows

The supporting processes and required resources have to be aligned with the different steps in the care process (Vera and Kuntz 2007). Current processes in healthcare must be modified to better coordinate, align and synchronize the different types of flows (i.e. supply, information and patient flows) and resources (i.e. staff equipment and materials). Ultimately, this should result in a more efficient and patient-centric workflow. The focus of operations management will therefore shift from ‘managing resources and capacity’ to ‘managing flows’ (Bohmer 2009).

A firm that adopts a process view in its organization, is concerned with the management of its business processes (Armistead and Machin 1997). While there are factors such as strategy, technology, people, etc. which impact organizational performance (Thorpe and Beasley 2004), the capability of managing and improving the organization’s business processes represents an important determinant of firm performance as well (Kohlbacher and Gruenwald 2011). This can be defined as continuous process improvement (CPI) (Ryan et al. 2013). It is a systematic approach understanding of the process capability, the customer’s needs, and the source of observed variation. An integral part of CPI is information about performance. Thus performance measurement is an essential requirement for purposeful BPM (Ryan et al. 2013). Although there is an extensive literature on how to measure process performance, most of these studies do not consider patient, materials and information flows in an integrated way. However, process-oriented performance measurement has been investigated separately for each flow. Extended literature reviews have been done in the field of healthcare logistics (Lega et al. 2013), information systems (Thatcher 2013) and a patient process-oriented organization (Vos et al. 2011).

Not only are managers more interested in process-oriented data, there is also an increasing amount of process-oriented data available in hospitals (Yigitbasioglu and Velcu 2012). This tendency gives opportunities to develop process-oriented performance measures based on existing databases. However, it is a challenge to capture and organize data to support and improve decision-making. The need to integrate large amounts of information across several levels or dimensions is a challenge. The problem of information overload can be managed by the use of interactive visual information displays to support decision-making (Chen 2010) and by implementing Key Performance Indicators in a dashboard. KPI's are "quantifiable metrics which reflect the performance of an organization in achieving its goals and objectives" (Bauer 2004). A dashboard brings the firm's KPI's into a single display (Lapointe 2005). It is a relatively small collection of interconnected key performance metrics and underlying performance drivers that reflects both short- and long-term interests to be viewed in common throughout the organization. Consequently, process-oriented KPI's can be visualized in a dashboard to support decision making in hospitals.

However, there are a couple of challenges in the development of the performance measurement systems in hospitals:

- Most performance measures in hospitals are not process-oriented (Gemmel et al. 2008) and cannot help a healthcare system to better synchronize the patients, materials and information flows. Many different stakeholders are having an impact on the performance of the different flows in a healthcare system. These stakeholders such as nurses, physicians, hospitals managers, suppliers, patients etc. all have their own view on performance and use different performance measures (Moore 2000). This leads to a large number of different potential performance indicators. Having a reliable method to selecting the 'key' performance indicators which are really able to steer flows and processes in healthcare is therefore an important challenge.
- As a result of insufficient powerful information systems and a lack of performance measurement tools within the healthcare sector, performance measures are not always complete and accurate (Eddy 1998). According to (Smith 2005) "uncritical reliance on performance data can lead to a number of unintended and adverse consequences".

This paper presents the development of an operational performance dashboard to measure, track and analyze the effects integrating patient, materials and information flows in a case study of hip surgery.

## **Methodology**

The objective of this study is to develop a methodology to supply an operational dashboard linking KPI's of an upstream patient process with downstream value-added data. To this end, case study research is a particularly approach (Yin 2013). Hence, our study took an in-depth comparative case study approach. The two case studies focus on the process within the operation room (OR) of two Belgian hospitals. The OR department is a key hospital resource, as 60–70% of all hospital admissions are induced by pathology requiring a surgical intervention (Denton et al. 2007). Denton et al. (2007) state that operating rooms (ORs) are the largest cost center and greatest source of revenues for most hospitals. Approximately 1/3<sup>rd</sup> of all surgeries are for orthopedic reasons, of which 10 to 15% are related to hip surgery in Belgium. Consequently, this orthopedic case study is a very relevant study within the setting of healthcare. The study was done in two different hospitals. The first hospital has a capacity of 822 beds, employs 2300 people and 220 physicians. The second hospital has a capacity of 554 beds, has more than 1600 employees and 170 physicians.

We use the framework of Pauwels et al. (2009) to develop an operational dashboard for hip surgery patients in the two hospitals. Pauwels et al. (2009) discuss the importance of the relationships between the demand and the supply side of dashboards. They state that the

adoption and success of dashboards is driven by five main factors: demand, supply (e.g., metrics availability), the fit between demand and supply, the implementation process, and the predisposition of users. In this paper we focus on the first three factors.

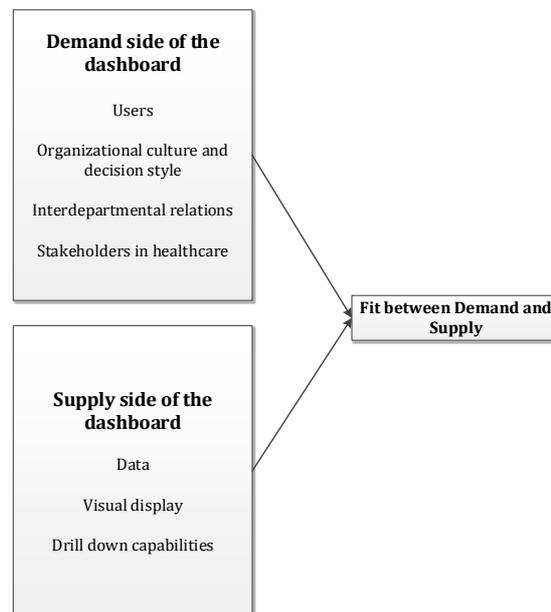


Figure 2- The adjusted framework of Pauwels et al. (2009)

In a first phase we investigated the demand-side of the dashboard, interviewing healthcare workers about which KPI's they find important to follow up. Figure 2 gives an overview of the framework adjusted to the healthcare setting. Yigitbasioglu and Velcu (2012) argue that KPI's should be developed and monitored at different levels within a hospital, depending on the goal and needs of the specific users. The level on which the dashboard should be implemented is determined by the selected KPI's. Since the strategic goals of an organization need to be broken down into objective targets for operating managers (Parida and Chattopadhyay 2007), an operational dashboard should employ the vision and strategic goals of a hospital (Dumas et al. 2013). Consequently, the KPI's must focus on a strategic and tactical level. Several frameworks such as the PATH framework can help us to define these strategic and tactical KPI's. In the PATH framework, satisfactory hospital performance is defined as "the maintenance of a state of functioning that corresponds to societal, patient, and professional norms". Six dimensions were identified for assessing hospital performance: clinical effectiveness, safety, patient centeredness, production efficiency, staff orientation and responsive governance (Veillard et al. 2005). Moreover, Donabedian (1988) states that structure, process as well as outcome indicators should be evaluated. Therefore, we investigated not only process-oriented indicators but also structure and outcome indicators. Eighteen qualitative semi-structured interviews were executed, incorporating the opinions of different users and actors of multiple disciplines involved in the management of patients, materials and information flows in the hip surgery cases.

The interview contained two phases:

*Part 1: a semi-structured interview.* Questions were asked on which performance indicators were measured in the hospital and the usefulness and importance of these performance indicators e.g. "Which performance-indicators are already measured in your organization?"

*Part 2: a structured interview.* This part was performed presenting a list of 138 KPI's to the interviewees. The list was based on a literature review. More precisely we updated the results of the systematic review of Liu and Itoh (2013) in which we searched articles in PubMed and

PubMed Central after 2012. We used a balanced scorecard to structure the KPI's. A balanced scorecard (BSC) is a strategy performance management tool that can be used by managers to keep track of the execution of activities by the staff within their control and to monitor the consequences arising from these actions (Niven 2014). It is built on four perspectives to identify what to measure and track for the implementation of strategy: (1) Financial perspective, (2) Customer perspective, (3) Internal business perspective and (4) Learning and growth perspective (Kaplan and Norton 2010).

The structured part in the interview consisted out of three steps: The list was shown to the interviewee by presenting the KPI's on cards. In the first step participants could select all indicators they found important and should explain why they are important (1). Next they had to select 20 KPI's they found most important to measure and follow up (2). Finally, they had to eliminate another 10 KPI's (3).

The recorded interviews were transcribed verbatim and analyzed using NVivo 10. Thereupon obtained data were content-analysed for emergent themes using the "framework approach" of Ritchie and Lewis (2003). We used the content of the interviews and the ranking of the KPI's to decide which KPI's should be integrated in the dashboard. The number of indicators monitored by a dashboard has to be manageable. In healthcare literature the number of KPI's range from 10 to 30. (Liu and Itoh 2013) created a list of 27 outcomes. 24 KPI's were measured in the research of (Harris et al. 2011). However, Shohet (2006) used only 11 KPI's. In this case we decided to retain 20 KPI's.

Second, to investigate the supply side of the framework, a detailed business process management study of the different flows in both cases was performed. Critical processes were identified using document analysis, semi-structured interviews and observations. Extra data was gathered from the hospital information system. Thereafter a focus group of several experts investigated which data could be linked to the KPI's. The focus group contained an IT-specialist out of the industry, 3 IT-researchers, 2 researchers in healthcare operations management, 1 hospital manager and a specialist in logistics management. The goal of the focus group was to bring the demand and the supply side of the framework together, which will result in a dashboard that amplifies analytical capabilities and capitalizes on human perceptual competencies in order to be used for operational decision-making.

## **Findings**

Following the method of Pauwels et al. (2009), we investigated the 4 perspectives of the balanced scorecard to evaluate which indicators should be implemented at the demand side. Different users and stakeholders were interviewed. The case study showed discrepancies in perspectives between professionals practicing at the hospital (i.e. physicians and head nurses) and hospital management. Cardinaels and Soderstrom (2013) state that each stakeholder uses a set of diverse criteria and standards to evaluate the legitimacy of the organization. Consequently, hospitals are subject to many internal pressures and different opinions. Moreover, the perspectives of professionals changed as the restrictions with respect to the number of indicators that they were allowed to select became smaller. Physicians, head nurses and the medical operating room managers tend to focus dominantly on the patient perspective contrary to administrative and nursing operating room management, who focused more on internal processes. Consequently, it is important to incorporate all different perspectives of the users who will use the dashboard.

Table 1- List of 20 KPI's



Key Performance Indicator	BSC
Surgery safety checklist	1
Occupancy OR	2
Number of hospitalization days	1
Performance evaluation of employees	3
Control guidelines of acute pain management	1
Duration of operating time per physician	2
Patient satisfaction with care/service	1
Number of times that a surgeon proceeds a surgery	3
Unplanned readmission	1
Job satisfaction survey	2
Materials missing during the operation in comparison to the bill of materials	2
Sickness absence	2
Cost per surgery	4
Incidence of decubitus	1
Waiting time before operation (from the moment the patient arrives at the hospital)	2
Correct preoperative medical screening	1
Frequency of renewed/replaced materials	2
PROM (Patient reported outcome measure)	1
Nosocomial infection	1
Mortality/Morbidity	1

Legend: 1: Patient Perspective, 2. Internal Business Process, 3. Learning and Growth, 4. Financial Perspective

The list of 20 KPI's in table 1 shows that the selected indicators are not equally divided over the four domains of the balanced scorecard. Only a few KPI's within the developed list are focusing on development and growth (10%) and financial perspective (5%). The priority of the participants is the patient's perspective (50%). However, waiting time between admission and surgery is shown to be important too. This indicates that participants value the patient flow.

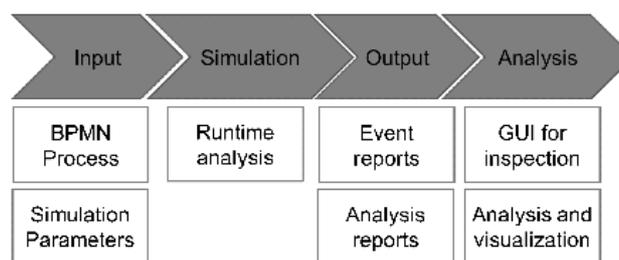
In a second phase, a detailed description and evaluation of the AS IS situation in the operating theatre is mapped in a BPMN-tool. Previous models use BPMN processes as backbone for a tool to simulate changes and impacts in processes (Strasser et al. 2010). Data mining and analysis algorithms are used to discover meaningful patterns or previously unknown knowledge. This phase of the research will be discussed in another paper. To outline the third phase of framework, linking data from the demand and supply side, a focus group was organized to link the results from the BPM study to the results of the KPI selection. During the focus group discussions we found that indicators were applicable in the dashboard using different techniques and procedures.

A first approach is to implement data directly into a dashboard applying real time generated data. Some KPI's are registered in the Hospital Information System (HIS) and can be linked straight away to the dashboard. These are often KPI's that are obligated by the government to report. Examples are incidence of decubitus, mortality/morbidity, number of readmissions, nosocomial infections, frequency of renewed materials, number of surgeries performed by a surgeon. Although, the last two are not obligated, they were found important by the interviewees.

The second approach is by using BPMN and Data from the HIS. Several KPI's, e.g. surgery safety checklist, performance evaluation of the employees, pain management and

preoperative screening, consist out of small tasks that have to be performed in the right order, in the right way and on the right moment. By using BPMN to outline these processes, linking the different tasks to the real time data from the HIS, these KPI's can be registered. First each task of the process is outlined using BPMN. Second, important data reflecting the quality of performance measurement is linked to the KPI's. We describe the surgery safety checklist as an example. The surgery safety checklist contains different steps and different questions that should be registered. Per question a BPMN-task can be performed. Second, different quality indicators can be coupled to the process e.g. verification (is the list checked by somebody else), completeness (are all tasks performed? Is every question of the form filled in?) and inconsistency. All this performance information is reflected in one KPI, the surgery safety checklist. However, using the drill-down capabilities of the dashboard a manager can trace certain underlying irregularities. Another advantage of this approach is that the tasks, in this case to fill in questions, can be made mandatory. If the surgery safety checklist is coupled to the IT-system in the OR, users can be obligated to fill in certain forms before the next screen is presented. This approach increases the reliability and response rate of the surgery safety checklist.

The third approach to implement data in a dashboard is simulation. Some KPI's that are process-oriented such as the waiting time before surgery, duration of an operation and the occupancy of an operating room, can not only be implemented in the dashboard using BPMN and data of an information system. Data can also be simulated using a simulation tool.



*Figure 3- Simulation Process*

Most of the Simulation Parameters are typically concerned with costs and availability of resources and timings and probabilities of the different process steps (tasks) involved. Simulation methods in a dashboard make it possible for managers to predict certain effects of strategy choices. If a manager for example choses to hire more employees, it is possible to see the hypothetical effect on other simulation parameters such as occupancy of the operation room and costs. Consequently, the dashboard becomes a very interesting working tool for the hospital.

KPI's that were related to satisfaction surveys were found less useful by the focus group to implement in a dashboard. It is still hard to ask patients and employees to fill in questionnaires. As long as these are not coupled to the HIS, it is not possible to collect data from individual questions. We decided to not incorporate these KPI's in the dashboard.

### **Relevance/contribution**

Since healthcare managers are looking with bigger interest to optimizations of process alignment, process-oriented performance measurement systems will become more important in the future. This paper contributes to the development of a performance measurement system for the process of hip surgery including process-oriented Key Performance Indicators.

It is a challenge for hospital management to integrate business functions and activities throughout supporting processes (Vickery et al. 2003). To analyze process flows in healthcare

it is important to evaluate the “full picture” of processes in healthcare. Downstream value-added processes have to be evaluated taking performance of the upstream surgery-relevant process into account (Villa et al. 2014). (Parida and Chattopadhyay 2007) state that performance measures, formerly used for operational control only, should achieve vertical and horizontal integration of activities across hierarchical levels e.g. operational, tactical and strategic levels within one organization. The key performance metrics need to reflect the vision and strategic goals of a hospital (Dumas et al. 2013). Moreover, it is crucial for managers to consider the opinion of different stakeholders while developing KPI's for the demand side (Paine 2004, Pauwels et al. 2009). Different professional groups have their own incentives, and conflicts among these groups can result in continuation of suboptimal accounting systems (Cardinaels and Soderstrom 2013). In this study we therefore interviewed physicians, nurses in middle and top management to capture the strategic and tactical goals for the process of hip surgery. Each group evaluates hospital's decisions from its own viewpoint (Ludwig et al. 2010). This study showed discrepancies between opinions of different stakeholder groups.

Second, the integration of data from the HIS into the dashboard is crucial for the incorporation of the supply side. Several expert focus groups were organized to investigate how and what should be implemented at the supply side of the dashboard. The collaboration of companies, research groups and hospitals made it possible to investigate downstream and upstream relationships at supplier-hospital interfaces. In this paper we outlined three different approaches to integrate data into the dashboard. Process-oriented performance measures were integrated using a combination of BPMN to outline processes with existing data from HIS. To our knowledge, this is a new approach to integrate process-oriented indicators in healthcare measurement systems.

A thorough understanding of the processes will also assist hospitals in their quest for accreditation. The current tendency towards accreditation and certification in the healthcare sector acknowledges the significance and will reinforce process management (Smith et al. 2013). Performance measures tell hospital managers how adequately their processes perform and are managed in order to meet the international standards. The major contributions of this paper are (1) the strategic goals of hospital management and different stakeholders are linked to the more analytical analysis of BPMN and HIS data and (2) a three-step approach to integrate process-oriented KPI's into a dashboard. We believe that this approach results in an operational dashboard which can be used by managers for decision-making. Moreover, the results of this study are realized because of the broad knowledge of the different partners participating in the focus groups. We state that better cooperation between hospitals, hospital suppliers and research groups can sustain process optimization in healthcare. Research should fit the demand of the healthcare sector integrating multidisciplinary knowledge of both academics and practice.

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